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Water Quality Evaluation of Ganga River from Up to Downstream Area at Kanpur City

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ABSTRACT

Ganga River is the major river of the country. The objective of present study is water quality evaluation of Ganga River in Kanpur city where industrial water mainly from tannery industries are removed. The deteriorating water quality of streams is due to anthropogenic activities and reducing fresh water availability. The industrial waste water (effluent) entering in Ganga river directly increases the river water pollution. Tanning industry is major source of Ganga pollution in Kanpur city. It is deteriorating the quality of water and aquatic flora. Total fifty water samples were collected since January 2012 to May 2012 to analyze the twelve physicochemical parameters. The industrial effluents in Ganga river are identified by their abnormality in different physiochemical parameters. The overall average values of these parameters during the study period were observed as pH (7.89± 0.63), Temperature (24.42±1.27^{0}C), Electrical Conductivity (233.28±139.70µs/cm),Total Dissolved solid(314.8±139.70 mg/l), Dissolved Oxygen (5.80±0.69 mg/l), Chemical oxygen Demand (43.9±12.87mg/l), Chlorine (30.46±9.48mg/l), Calcium (104.74±14.45mg/l), magnesium (82.78±16.05mg/l), Calcium Carbonate (223.58±54.32mg/l) and turbidity (57.87±20.02 NTU). The industrial effluent increases the nutrient load in the river due to eutrofication (algal blooms) takes place.

Keywords: Ganga River, Water Quality, Waste water, Tannery Industry and Kanpur.

1. INTRODUCTION

Water as resources is under relentless pressure due to population growth, rapid urbanization, large scale industrialization and Environmental concern (Rai and Pal, 2002). One out of three people in the developing countries does not have

access to safe drinking water and some 123 freshwater animal species have gone into extinction in North America (Smol, 2002). Rivers are water ways of strategic importance across the world, providing main water resources for domestic, industrial and agricultural purposes (Faith, 2006). The quality of a river at any point reflects several major influences, including the lithology of the basin, atmospheric inputs, climatic conditions and anthropogenic inputs (Bricker and Jones, 1995). Climate change rainfall scenarios also suggest that annual rainfall will decrease by up to 5% and this will be experienced in Namibia, Mozambique and parts of Zimbabwe and South Africa (Hirji *et al*., 2002). Aquatic ecosystem is getting polluted day by day due to the growth of industrial corridor, nutrient loading and rapid anthropogenic activities especially in developing countries (Kumar and Pal, 2010). Surface water quality of the rivers of Bangladesh is highly polluting day by day (DoE 1993, Hossain, 2001). River system is the primary means for disposal of waste, especially the effluents, from industries that are near them. The river Gomti got highly polluted downstream of Lucknow due to human interference and input of municipal and industrial waste water (Bhatt and Pathak, 1992).The effluent from industries have a great deal of effluent on the pollution of the water body, these effluent can alter the physical, chemical and biological nature of receiving water body (Sangodoyin,1991). Industries are the major sources of pollution in all environments. Wastewater from industries includes employs, sanitary waste and process waste from manufacturing, wash waters and relatively uncontaminated water from heating and cooling operations (Glyn and Gary, 1996). These industrial pollutants degrade ecosystem many folds, pollute the water bodies or stream, damage aquatic ecosystem and damage the soil fertility and soil sub ecosystem (Kumar *et al.,* 2010). The tannery industry mushrooming in North India has converted the Ganga river into a dumping ground. The tanning industries discharge different types of waste in the environment, primarily in the form of liquid effluents containing organic matter, chromium sulphide, ammonium and other salts (Beg and Ali, 2008). In the month of march, the climatic condition differed and was indicated through higher salinity (EC) and hardness values. The concentration goes down in Monsoon season due to huge fresh water discharge through the river and natural cleaning process remains operating (Devi *et al*., 1991). Monitoring of Ganga river from Rishikesh to Varanasi indicated that Kannauj to Kanpur and Varanasi are the most polluted stretches of river Ganga (Singh *et al*., 2003). The analysis of upstream and downstream water and sediments revealed 10 folds in Chromium level in sediments at downstream Jajmau area at Kanpur showing unchecked release of untreated tannery effluent (Khwaja *et al*., 2001).

Kanpur is also known as Industrial city in world which is mainly famous for tanneries, footwear, manufacturer and leather industries. State of Utter Pradesh alone responsible for over 50% of the pollutants entering the river along journey of sea. Ganga river water is brown black in colour from Narora to Varanasi but mainly at Kanpur. The river is still the private garbage dump of industries. In Kanpur, there

are 19 drains carrying raw sewage directly to river Ganga.

Over all tanneries waste water plays a significant role in deteriorating the water quality of Ganga river in Kanpur city. The discharge of tannery waste water increases from January to May because of higher production rate in tanning industry due to this water quality decreases. Number of industries mainly leather industry continuously increasing in river bank stress near downstream of river Ganga due to this contamination of water is also increases. To study the extent of pollution in river water we have selected the Ganga river, which is subjected to enormous anthropogenic activities, receive heavy inputs of domestic waste and industrial effluents. The aim of present study therefore, focused on water quality status from up to downstream of Ganga river at Kanpur City.

2. METERIALS AND METHODS

Study Area

The district Kanpur lies between $80^0$21" East longitude and $26^0$28" North latitude in Uttar Pradesh, India. The population of Kanpur is at present near 38 lakh according 2010 census and it may be projected 56 lakh in 2025. Ten Sampling Sites were selected along the Bank of Ganga river at Kanpur city (Fig- 1).

Sample Collection

Samples are taken from 10 different sites namely as (Bithoor (S1), Bithoor after town (S2), Ganga Barrag (S3), Paramath Ghat (S4), Sarsiaya Ghat (S5), Rani Ghat (S6), Miaskan Ghat (S7), Jajmau (S8), Siddhanath Ghat (S9) and Dhori Ghat (S10)**)** during months from January 2012 to May 2012 (Fig.-1). The physical parameters like pH, Temperature, DO are recorded on the spot and other chemical parameters like E.C., TDS, BOD, COD, Cl, Ca, Mg, $CaCO_3$ and Turbidity are recorded in the Laboratory which are carried out to referring 'standard methods' (APHA 2005).

3. RESULT AND DISCUSSION

pH*:* pH of the aquatic system is an important indicator of the water quality. In the present study, pH is positively correlated with temperature. The average pH values at all ten sites were recorded to be varying between 7.6±0.66 (May) to 8.1±0.45 (April). It has been mentioned that the increasing pH appear to be associated with increasing use of alkaline detergents in residual areas and alkaline material from waste water in industrial areas (Chang, H., 2008). The minimum and maximum value of pH is 7.0 in month of January at site S1 and 9.5 in month of March at site S10. The Ganga river water represents alkaline pH throughout the study period.

Temperature: Temperature is an important parameter, which directly related with the chemical reaction in the water and biochemical reaction in the living organism (Kumar *et al.*, 2010). Temperature and photoperiod are the important factors which control the behaviour, physiology and distribution of organism (Shrivastav *et al*., 2009). The average value of temperature at all Ten sites were ranged between 18.75±0.95 (January) to 29.35±1.02 (May). Temperature was found negatively correlated with DO (Das, 2000) and

positively correlated with turbidity (Pradhan *et al*., 2003). The minimum value of temperature is found 18.0^0C in month of January at site S1(upstream) and maximum value is observed 31.0^0C in month of May at site S9 (Siddhinath Ghat) because of effluent releasing from leather and tannery industries. Temperature shows a positive correlation with BOD and COD.

Conductivity: Conductivity is a good and rapid method to measure the total dissolved ions and directly related to total solids. Higher the value of dissolved solids, greater the amount of ions in water (Bhatt *et al*., 1999). The average range of electrical conductivity from all ten sites were recorded between 183.3µS/cm ± 84.26 (January) to 264µS/cm ± 159.7 (April). The minimum and maximum value of conductivity is 98µS/cm in month of May at site S1(upstream) and 610µS/cm in month of April at site S9(downstream).

Total Dissolved Solid*:* Total dissolved solid is particularly useful in the analysis of industrial waste water. It signifies the inorganic pollution load of water system (Usha *et al*., 2008). The average values of total dissolved solid at all ten sites were ranged between 208.5±103.92mg/l (January) to 367.8±173.63mg/l (April).). The minimum and maximum value of TDS is 120mg/l in month of January at site S3 and 710mg/l in month of April at site S9.

Dissolved Oxygen*:* Dissolved Oxygen value is remarkable in determining the water quality criteria of an aquatic system (Kumar *et al*., 2011). DO concentration decreases in water during summer season due to decreased rate of oxygen diffusion from atmosphere to water. DO is negatively correlated with Temperature and negetively correlated with COD and BOD. The average values of DO at all ten sites were varied from 6.22±0.70mg/l (February) to 5.32±0.57mg/l (April). The site 9 (Siddhanath Ghat) shows minimum concentration 4.2mg/l in month of April because of highly biological oxygen demand due to high water pollution of tannery industries and Site S1 (upstrwam)is found to be maximum concentration 7.6 mg/l in month of March.

Biological Oxygen Demand: Biological oxygen Demand is a measure of oxygen in the water that is required by the aerobic organisms. The biodegradation of organic materials experts' oxygen tension in water and increases the biochemical oxygen demand (Abida *et al*., 2008). BOD has been fair measure of cleanliness of any water on the basis that values less than 1-2 mg/l are considered clean, 3 mg/l fairly clean, 5 mg/l doubtful and 10 mg/l definitely. During the study period, the average value of BOD varied from 2.72±1.02 mg/l (February) to 4.19±0.95 mg/l (January)**.** The minimum and maximum value of BOD is 1.8 mg/l in month of April at site S5 and 8.0 mg/l in month of May at site S10.

Chemical Oxygen Demand: COD is an oxygen demand to decompose the biodegradable as well as non biodegradable organic waste. The measure of COD determines the quantities of organic matter found in water. This makes COD useful as an indicator of organic pollution in surface water (King *et al*., 2003). COD pointing to a deterioration of water quality likely caused

by discharge of municipal waste water (Mamais *et al*., 1993). The average values of COD at all Ten sites were found to be ranging from 40.1± 9.48mg/l (February) to 49.3±15.86mg/l (April). The minimum and maximum value of COD is 20.0 mg/l in month of March at site S1(upstream) and 83.0 mg/l in month of April at site S8 (Jajmau) because of entering of industrial waste through jajmau nala.

Chlorides: High concentration of Chloride is considered to be the indicator of pollution due to organic wastes of animal or industrial origin. Chlorides are troublesome in irrigation water and also harmful to aquatic life (Rajkumar *et al*., 2004). During study period, the average value of chloride ranging from 26.25± 5.24 mg/l (February) to 38.8± 11.59mg/l (April). The minimum value of Chloride is observed 17.0 mg/l at site 4(Parmath Ghat) as this site is religious temple and maximum value is 67.0 mg/l in month of April at site S9 (Siddhnath Ghat) due to addition of industrial effluent through nala.

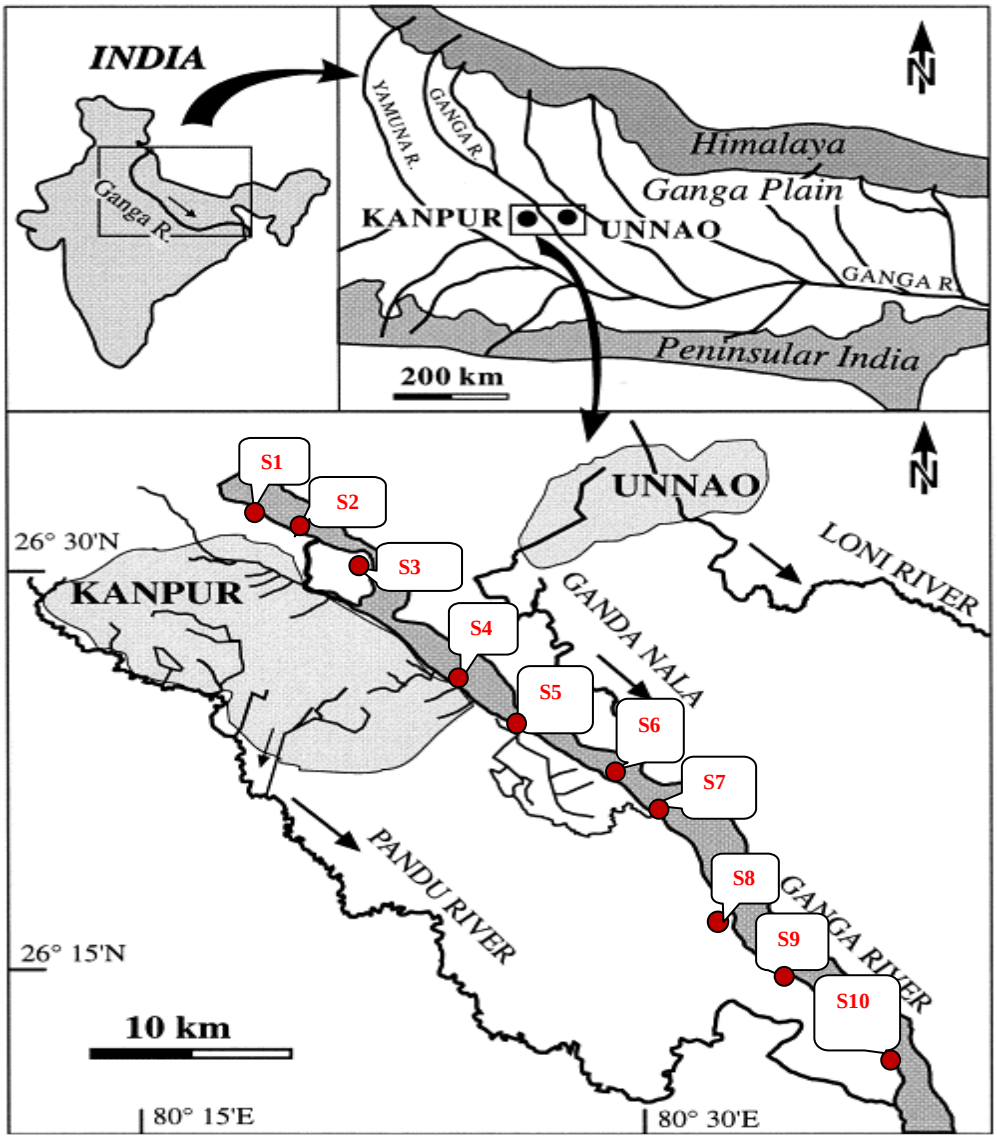
Calcium & Magnesium (Total hardness): Total hardness is a parameter of water quality used to describe the effect of dissolved mineral (Ca and Mg), determining solubility of water for domestic, industrial and drinking purpose attributed to presence of bicarbonates, sulphate, chloride and nitrates of Calcium and Magnesium (Taylor, 1949). During the study period, the average values of Calcium is 95±32.25 mg/l (January) to 113± 46.67 mg/l (April) and Magnesium is 74.1±21.72 mg/l (May) to 88.2±14.71 mg/l (April). The minimum and maximum value of Calcium is 16.0 mg/l in month of April at site S10 (downstream) and 195 mg/l in month of April at site S9 (Siddhnath Ghat). The minimum and maximum value of Magnesium is 35.0 mg/l in month of May at site S1(upstream) and 115 mg/l in month of April at site S8(Jajmau).

Calcium Carbonate: During the study period, the average value of Calcium Carbonate in all ten sites are varied from 179±18.73 mg/l (January) to 286.5± 111.97mg/l (April). The minimum and maximum value of $CaCO_3$ is 160 mg/l in month of January at site S1(upstream) and 525 mg/l in month of April at site S9(Siddhnath Ghat).

Turbidity: Water transparency is an important factor that controls the energy relationship at different tropic levels. It is essentially a function of reflection of light from the surface and is influenced by the absorption characteristics of both water and of its dissolved and particulate matter (Stepane *et al*., 1959). During study period, the average value of Turbidity in all ten sites are varied from 95.1±12.39 NTU (May) to 129.8±23.92 NTU (April). The minimum and maximum value of turbidity is 60 NTU in month of February at site S5 (Sarsaiya Ghat) due to addition of waste water of cant nala and and 170 NTU in month of April at site S9 (Siddhanath Ghat). Turbidity is found to be negatively correlated with temperature.

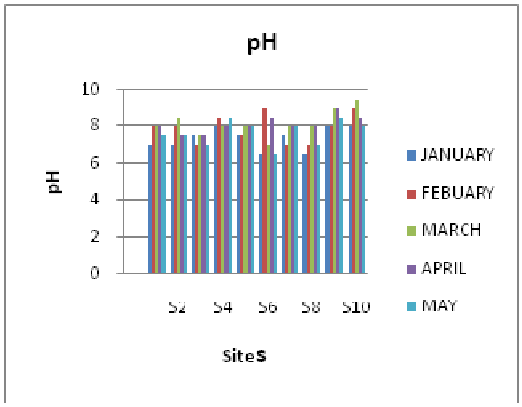
The average values of monthly variation in physicochemical parameters of water collected from different months of the Ganga river has been shown in Table-1 and their correlation in Table-2. The average values of site wise variation of different

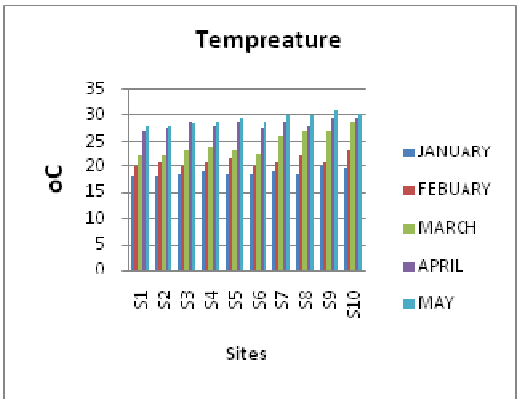
parameters of water quality Ganga river has been shown in fig- 2.



S1= Bithoor, S2= Bithoor after Town, S3= Ganga Baraj, S4= Paramath Ghat,
S5= Sarsaiya Ghat, S6= Rani Ghat, S7= Maiskan Ghat, S8= Jajmau,
S9= Siddanath Ghat, S10= Dhori Ghat.

Fig1. Showing different Sites of Ganga River at Kanpur City (Up to downstream).


pH
pH
10
8
6
4
2
0
S2
S4
S6
S8
S10
Sites
JANUARY
FEBUARY
MARCH
APRIL
MAY


Tempreature
oC
35
30
25
20
15
10
5
0
S1
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S3
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S5
S6
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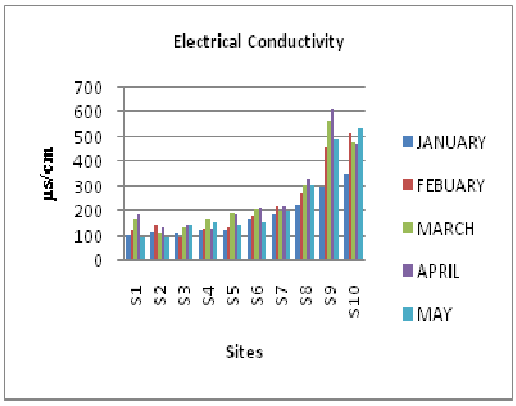
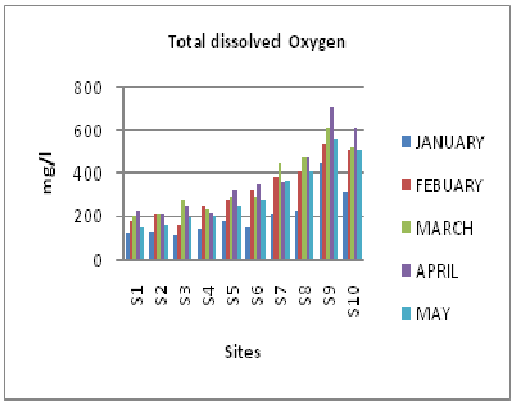
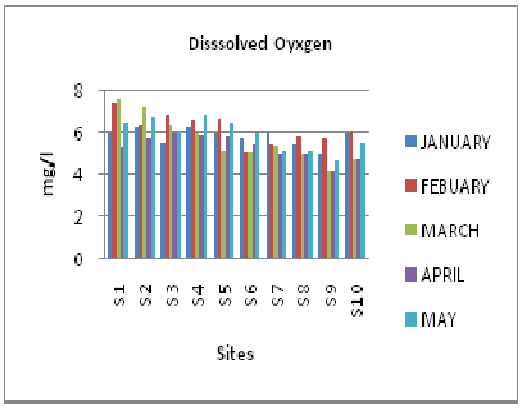
S8
S9
S10
Sites
JANUARY
FEBUARY
MARCH
APRIL
MAY


Electrical Conductivity
µs/cm
700
600
500
400
300
200
100
0
S1
S2
S3
S4
S5
S6
S7
S8
S9
S10
Sites
JANUARY
FEBUARY
MARCH
APRIL
MAY


Total dissolved Oxygen
mg/l
800
600
400
200
0
S1
S2
S3
S4
S5
S6
S7
S8
S9
S10
Sites
JANUARY
FEBUARY
MARCH
APRIL
MAY


Disssolved Oyxgen
mg/l
8
6
4
2
0
S1
S2
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S9
S10
Sites
JANUARY
FEBUARY
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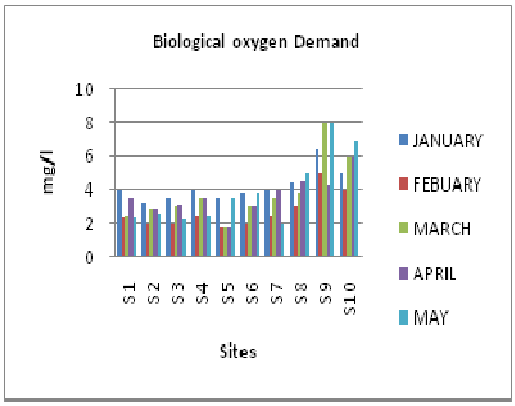
APRIL
MAY


Biological oxygen Demand
mg/l
10
8
6
4
2
0
S1
S2
S3
S4
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S6
S7
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S9
S10
Sites
JANUARY
FEBUARY
MARCH
APRIL
MAY

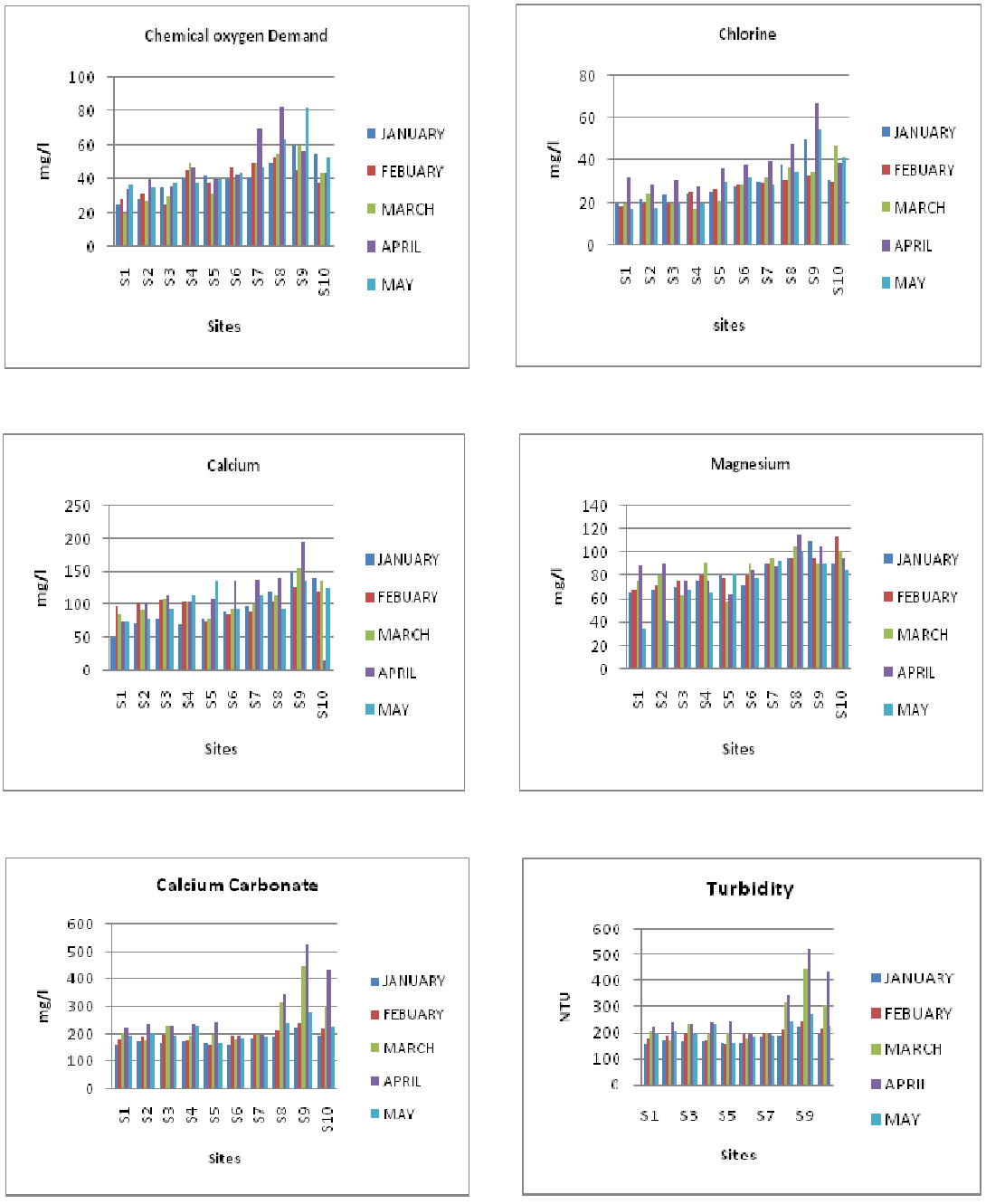

Fig 2. Showing different parameters with minimum and maximum value among different sites at different months.

Table 1. Average value of monthly variation in physicochemical characteristics of Ganga River Kanpur City at All ten sites (up to downstream)

	January	February	March	April	May	Over All
pH	7.7±0.57	7.9±0.77	8.15±0.70	8.1±0.45	7.6±0.66	7.89±0.63
Tem(0C)	18.75±0.95	21.05±2.49	24.55±0.90	28.4±1.02	29.35±1.02	24.42±1.27
EC(µs/cm)	183.3±84.26	230.6±145.63	252.8±149.86	264.4±159.70	235.3±159.97	233.28±139.70
TDS(mg/l)	208.5±103.92	327.5±131.32	360±145.43	367.8±173.63	311±144.23	314.8±139.70
DO(mg/l)	5.84±0.39	6.22±0.70	5.69±1.08	5.32±0.57	5.95±0.75	5.80±0.69
BOD(mg/l)	4.19±0.95	2.72±1.02	3.79±1.84	3.64±1.13	3.91±2.10	3.65±1.40
COD(mg/l)	41.6±11.04	40.1±9.48	40.8±13.19	49.3±15.86	47.7±14.81	43.9±12.87
Cl(mg/l)	29.25±8.93	26.25±5.24	28.25±9.53	38.8±11.59	29.75±12.12	30.46±9.48
Ca(mg/l)	95±32.25	101.9±15.78	107.3±22.97	113±46.67	106.5±21.60	104.74±14.45
Mg(mg/l)	81.7±14.32	84.9±13.84	85±15.72	88.2±14.71	74.1±21.72	82.78±16.05
CaCO3(mg/l)	179±18.73	196.5±22.49	245.3±86.41	286.5±111.97	210.6±32.04	223.58±54.32
Turbidity(NTU)	112.3±25.31	81.2±14.49	100±24.03	129.8±23.92	95.1±12.39	57.87±20.02

Table 2. Correlation matrix between physicochemical parameters of Ganga River, Kanpur (up to downstream)

	pH	Temp. (0C)	EC (µs/cm)	TDS (mg/l)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	Cl (mg/l)	Ca (mg/l)	Mg (mg/l)	CaCO3 (mg/l)	Turbidity (NTU)
pH	1											
Tem(0C)	0.446	1										
EC(µs/cm)	0.921	0.755	1									
TDS(mg/l)	0.956	0.659	0.988	1								
DO(mg/l)	-0.410	-0.464	-0.482	-0.391	1							
BOD(mg/l)	-0.443	0.131	-0.311	-0.439	-0.459	1						
COD(mg/l)	0.109	0.841	0.453	0.335	-0.593	0.293	1					
Cl(mg/l)	0.303	0.569	0.476	0.387	-0.880	0.248	0.820	1				
Ca(mg/l)	0.805	0.867	0.964	0.915	-0.622	-0.126	0.667	0.657	1			
Mg(mg/l)	0.616	-0.224	0.364	0.432	-0.462	-0.380	-0.176	0.373	0.275	1		
CaCO3(mg/l)	0.804	0.681	0.876	0.828	-0.838	0.002	0.586	0.788	0.925	0.536	1	
Turbidity(NTU)	0.070	0.262	0.155	0.059	-0.921	0.551	0.591	0.888	0.346	0.383	0.604	1

4. CONCLUSION

The present investigation concluded that the water of Ganga river is found to be polluted in respect to analysed parameters. Ganga is dying both physically and biologically. The water in Ganga river throughout the city, from Bithoor (S1) to Dhori Ghat (S10) fast losing its individuality. The source of pollution in the river is sewage effluents that have considerably spoiled the quality of its water in this stretch of the river. At Siddhnath Ghat (S9), river is highly polluted because of solid waste generated in tanning process and tannery effluent discharge in to the river as compared to other Ghats indicated by higher levels of DO.

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